Claims

1. A method for electroblowing fibers comprising:

forcing a polymer fluid through a spinneret in a first direction towards a collector located a first distance from said spinneret, while simultaneously blowing a gas through an orifice that is substantially concentrically arranged around said spinneret, wherein said gas is blown substantially in said first direction;

wherein an electrostatic differential is generated between said spinneret and said collector; and

collecting the fibers.

2. The method of claim 1, wherein said collecting is performed by applying shear and elongational forces on the polymer fluid between said spinneret and said collector to further stretch the polymer fluid and deposit submicron sized fibers on the collector.

3. The method of claim 1, wherein said polymer fluid is a polymer melt.

4. The method of claim 1, wherein said polymer fluid is a polymer-containing solution comprising a polymer and a solvent.

5. The method of claim 4, wherein said polymer-containing solution comprises a mixture of two or more polymers and one or more solvents.

6. The method of claim 1, wherein said polymer fluid comprises a polymer suspension comprising a polymer and a solvent, optionally comprising suspended particles.

7. The method of claim 6, wherein said polymer suspension comprises a mixture of two or more polymers and one or more solvents, optionally comprising suspended particles.

8. The method of claim 1, wherein said electrostatic differential is generated by applying an electrostatic potential between said spinneret and said collector.

9. The method of claim 1, wherein said electrostatic differential is generated by applying an electrostatic potential to a secondary electrode and said collector.

10. The method of claim 1, wherein said gas is a member selected from air, nitrogen, reactive gases, inert gases and mixtures thereof.

11. The method of claim 10, wherein said gas is air.

12. The method of claim 1, wherein said gas is heated.

13. The method of claim 1, wherein said gas is cooled.

14. The method of claim 13, wherein said gas is cooled to a temperature in a range from -50°C to 350°C.

15. The method of claim 1, wherein said polymer fluid comprises one or more polymers selected from the group consisting of hyaluronan, polyalkylene oxides, poly(meth)acrylates, polystyrene based polymers and copolymers, vinyl polymers and copolymers, fluoropolymers, polyesters, polyurethanes, polyalkylenes, polyamides, polyaramids, natural polymers and copolymers and mixtures thereof.

16. The method of claim 1, wherein said polymer fluid comprises one or more polymers selected from the group consisting of hyaluronan, poly(ethylene oxide), polyacrylonitrile, poly(methyl methacrylate), poly(2-hydroxyethyl methacrylate), polystyrene, poly(ether imide), polycarbonate, poly(caprolactone), poly(vinyl chloride), poly(glycolide), poly(lactide), poly(p-dioxanone), poly(ethylene-co-vinyl alcohol), polyacrylic acid, poly(vinylacetate), poly (pyrene methanol), poly(vinyl phenol), polyvinyl pyrrolidone, poly(vinylidene fluoride), polyaniline, poly(3,4-polyethylenedioxythiothene), polypropylene, polyethylene, butyl rubber, polychloroprene, acrylonitrile-butadiene-styrene triblock copolymer, styrene-butadiene-styrene (SBS) triblock copolymer, poly(urethane), poly(urethane urea), poly(amic acid), polyesters, polyamides, polyaramid, poly(p-phenyleneterephthalamide), polybenzimidazole, poly(ferrocenyldimethylsilane), starch, cellulose acetate, collagen, fibrinogen, fibronectin, Bombyx mori and Samia cynthia ricini

silk fibroins, elastin-mimetic peptide polymers, enzyme-lipase, nucleic acids, polysaccharides, and copolymers and mixtures thereof.

17. The method of claim 16, wherein said polymer fluid comprises a member selected from the group consisting of hyaluronan, copolymers of hyaluronan and mixtures thereof.

18. The method of claim 17, wherein said polymer fluid is a hyaluronan-containing solution comprising a solvent and from 0.01 to 8 wt % of a member selected from the group consisting of hyaluronan, copolymers of hyaluronan and mixtures thereof.

19. The method of claim 18, wherein said solvent comprises a member selected from the group consisting of water, minimal essential medium (Earle's salts), chloroform, methylene chloride, acetone, 1,1,2-trichloroethane, dimethylformamide (DMF), tetrahydrofuran (THF), methanol, ethanol, 2-propanol, dimethylacetamide (DMAc), N-methyl pyrrolidone, acetic acid, formic acid, hexafluoro-2-propanol (HFIP), hexafluoroacetone, 1-methyl-2-pyrrolidone, glycerol, low molecular weight poly(ethylene glycol), low molecular weight paraffins, low molecular weight fluorine-containing hydrocarbons, low molecular weight fluorocarbons , and mixtures thereof.

20. The method of claim 1, wherein said electrostatic differential is from 1 to 100 kV.

21. The method of claim 20, wherein said electrostatic differential is from 15 to 50 kV.

22. The method of claim 21, wherein said electrostatic differential is from 30 to 45 kV.

23. The method of claim 1, wherein said gas is blown at a rate of up to the velocity of sound.

24. The method of claim 23, wherein said gas is blown at a rate of up to 300 SCFH.

25. The method of claim 24, wherein said gas is blown at a rate of from 10 to 250 SCFH.

26. The method of claim 25, wherein said gas is blown at a rate of from 30 to 150 SCFH.

27. The method of claim 12, wherein said gas is heated to a temperature of up to 350°C.

28. The method of claim 27, wherein said gas is heated to a temperature of from 25 to 120°C.

29. The method of claim 28, wherein said gas is heated to a temperature of from 40 to 90°C.

30. The method of claim 13, wherein said gas is cooled to a temperature of down to -100°C.

31. The method of claim 30, wherein said gas is cooled to a temperature in the range of from -50 to 25°C.

32. The method of claim 31, wherein said gas is cooled to a temperature in the range of from -20 to 10°C.

33. The method of claim 1, wherein a charge density of said polymer fluid is increased by injection of electrostatic charges into said polymer fluid.

34. The method of claim 1, wherein said collector is maintained at a temperature in the range of from -20 to 80°C.

35. The method of claim 4, wherein said gas is blown at a rate and a temperature sufficient to cause substantial evaporation of said solvent prior to the fibers reaching said collector.

36. The method of claim 1, wherein said electrostatic differential is generated by application of an electrostatic potential in proximity to said collector and on a side of said collector opposite to said spinneret.

37. Hyaluronan nanofibers having a diameter of from 10 nm to 1000 nm.

38. Hyaluronan fibers produced by the method of claim 1.

39. A biomedical material comprising hyaluronan nanofibers according to claim 37.

40. A biomedical material comprising hyaluronan nanofibers according to claim 38.